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The Impact of Employing the 'Six Thinking Hats' Strategy on the Development of Creative Thinking Skills and Trends Towards Mathematics Among Sixth Grade High-Achieving Students in Mathematics

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Abstract: This study aimed to investigate the impact of employing the 'Six Thinking Hats' Strategy on the development of creative thinking skills and trends towards mathematics among sixth grade students, who are high-achievers in mathematics. To achieve the objectives of the study, the researchers used the quasi-experimental design, with a study sample consisting of an experimental group made up of 33 students, who were required to sit for a pre-and-a post test. The study tools consisted of a test for creative thinking skills and a scale of trends towards mathematics. The study results showed that there were significant statistical differences between the pre and post scales in creative thinking skills and the scale of trends towards mathematics; this difference is in favor of the post application of the scale.

Keywords:' Six Thinking Hats' Strategy, Creative thinking skills, High –achieving , Mathematics

1. INTRODUCTION

The current era is characterized by rapid changes, successive discoveries and a knowledge revolution covering all fields, which requires the preparation of individuals who are capable of straight thinking and are qualified to face the challenges of the progress of knowledge and technology in this era.

The goal of the teaching and learning process is to shift interest from knowledge and information to the development of the students' minds to acquire the ability to conclude, imagine, invent, critique, create, in addition to other higher thinking skills. To achieve this, we should focus on the development of thinking patterns and refine the learner's abilities to develop, organize, store and employ the methods of mental processing of acquired knowledge (Al Sayyed and Ahmed, 2009: 307).

Mathematics has been and will continue to be the servant and queen of all sciences, being a school of creativity and a forum for creators, for which its study develops the mental abilities of the learner, orienting them towards authenticity and flexibility, and its passion stimulates the mind and pushes it towards challenges. Moreover, educators agree that mathematics is one of the most important subjects that is considered a fertile ground for the development of thinking methods generally, and creative thinking particularly (Muselhi and Abdullah, 2012: 171). Also, The National Council of Teachers emphasizes the need to provide appropriate methods to develop students' ability to practice creative thinking, by focusing on strategies that develop creative thinking within the classroom (Forster, 2012: 283).

Creative thinking is a complex mental activity that results from guided mental processes, the use of mathematical skills, the recall of mathematical expertise and related knowledge, with the aim of reaching new and valuable production that enables the individual to adapt to life variables, handle mathematical and non-mathematical problems intelligently, and make right decisions.

Creativity has three major skills: Fluency, originality, and flexibility (Adam, 2014:4-5). Creative thinking enables high-achieving students to recognize their problems and emotions and to express them accordingly, which is of high importance as those students are considered the munitions of the present and the leaders of the future; thus, their welfare is an essential sphere for educational development. In this regards, educators believe that the investment in the talents of the outstanding students is one of the important fundamental

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issues in our contemporary world, as the educational curriculum does not stimulate their imagination, nor their curiosity, nor does it challenge their abilities, or leave an opportunity for them to express their opinions, which results in the student's loss of the spirit of challenge as a result of repetitive routine practiced in the classroom. Therefore, if not provided with programs that meet their needs, students become more prone to problems (Sa'adu, 2008: 243-252).

In light of the interest in the teaching of thinking and the development of skills of high-achievers, it is necessary for the teacher to use modern methods and strategies that develop creative thinking, including the strategy of the six thinking hats proposed by De Bono, which is a strategy that includes six types of thinking for the individual assigned with different colors, of which each color symbolizes a different type of thinking. The strategy of the six hats aims to simplify thinking and increase its effectiveness, allowing the learner to move from one mode of thinking to another (Nofal, 2009: 202).

The Six Thinking Strategy is one of the most significant educational strategies in the field for improving and teaching thinking and developing its various skills, making the teachers and learners more active and effective, by which de Bono concluded that:

- The Western society's way of thinking is limited to technical quality only, which is based on debates, by which each individual attempts to predominate the other, thus making each idea faced by an opposite one.
- When the individual thinks, they normally employ all different types of thinking at the same time, which leads to confusion, misunderstanding and lack of concern and rationality, and results in subjective conclusions.

For this, De Bono designed the Six Thinking Hats strategy to help individuals think rationally and realistically, making them more productive (Kharrazah, 2016: 579).

The Six Thinking Hats strategy aims to enable students to use at the same time one pattern of thinking by linking the color of each hat with a way that matches the nature and quality of its thinking:

The white hat is a symbol of neutrality, representing neutral thinking; the red hat is a symbol of expression of emotions and feelings; the black one symbolizes negativity of things; the yellow one is a symbol of optimism and constructive thinking and brightness; while, the green hat symbolizes creativity and generation of new ideas; and finally the blue one represents organization of thinking and reaching learning outcomes. (Habib, 2013: 181).

All of the above emphasize the need to utilize the Six Thinking Hats strategy in developing the skills of creative thinking and trends towards mathematics among sixth grade students who are high-achievers in mathematics, as the strategy enables the presentation of the educational material in an exciting educational and scientific way, which attracts students towards creative thinking and raises their motivation towards learning.

The researcher sensed the problem of this study and the need for addressing it based on the following:

- The importance of developing the skills of creative thinking and trends towards mathematics, and the right of every student, especially high-achieving students, to have the opportunity to develop their creativity skills to the maximum of their abilities.
- The need to respond to some of the previous studies that recommended the development of creative thinking in mathematics, such as the studies of Rabie (2017), Ashour (2015), Mushtaha (2015), and Siam (2013).

In light of the foregoing, there is an urgent need to carry out such a study, which aims to answer the following main question:

What is the impact of the employment of De Bono's 'Six Thinking Hats' Strategy on the development of creative thinking skills and trends towards mathematics among sixth grade high-achieving students in mathematics?

To answer this question, the following sub-questions have to be answered:

1. What creative thinking skills should be developed among sixth grade students who are high-achievers in mathematics?
2. What is the impact of the employment of the 'Six Thinking Hats' strategy on the development of creative thinking among sixth grade students who are high- achievers in mathematics?
3. What is the impact of the employment of the 'Six Thinking Hats' strategy on the development of trends towards mathematics among sixth grade students who are high-achievers in mathematics?

A. Study Hypotheses:

The study aims to verify the validity of the following hypothesis:

1. There are no significant statistical differences ($\alpha \leq 0.05$) between the mean scores of the high-achieving students in the pre-and-post tests of creative thinking skills.

2. There are no significant statistical differences ($\alpha \leq 0.05$) between the mean scores of the high-achieving students in the pre and post scale of trends towards mathematics.

B. Significance of the study

The study is expected to contribute to the following:

1- This study may be useful for mathematics teachers in helping them develop teaching and evaluation methods and in presenting educational activities of mathematical lessons in new ways.
2- It may be useful for mathematics supervisors in training new teachers on using the 'Six Thinking Hats' strategy in teaching.
3- This study provides some tools which can benefit researchers in the preparation of similar studies, such as the test of creative thinking and the scale of trends towards mathematics.
4- The results of this study benefits the specialists responsible for preparing the Palestinian curriculum in the presentation and organization of concepts, skills and geometric generalizations for fourth grade students, in a way that develops their thinking and geometric achievement.
5- The current study may open new avenues for researchers to conduct future studies in the use of the 'Six Thinking Hats' strategy in the educational process, at different stages of teaching and in various educational courses.

C. Limitations of the study:

This study is limited to the following:

- **Objective limit**: The study was limited to determining the impact of employing the 'Six Thinking Hats' strategy on the development of creative thinking skills and trends towards mathematics among sixth grade students who are high-achievers in mathematics
- **Institutional Limit:** Schools of the Ministry of Education in Gaza.
- **Spatial limit**: Sabha Al Harazeen Boys Primary School.
- **Human limit:** A purposive sample of sixth graders who are high-achievers in mathematics.
- **Time limit:** First semester of the academic year 2017-2018.

D. Operational definitions of the study:

- **Six Thinking Hats Strategy:** A set of procedural steps in light of De Bono's theory, in which the teacher follows on the development of creative thinking skills and trend towards mathematics among sixth grade students; these colors include the white color (information and facts), red (emotions and feelings), black (negative aspects), yellow (positive aspects), blue (assessing things and prioritizing), green (new ideas).
- **High-Achieving Students:** Sixth grade students in Gaza Governorate who have obtained 90%+ in mathematics and possess high cognitive skills and abilities in mathematics.
- **Creative Thinking:** A mental process that aims to solve a mathematical problem to reach authentic results based on fluency, flexibility and originality and is measured by the scores of students in the creative thinking test.
  - **Fluency:** The student's ability to generate the greatest number of correct solutions for the mathematical problem, measured by the scores obtained by students on the measure of fluency in the test of creative thinking.
  - **Flexibility**: The student's ability to generate a number of ideas to solve the mathematical issue, measured by the grades obtained by students on the measure of flexibility in the test of creative thinking.
  - **Originality:** The student's ability to solve the mathematical problem is a non-repetitive solution, measured by the degree to which the students are able to measure the skill of originality/uniqueness in the test of creative thinking.
- **The Trend towards Mathematics:** An acquired psychological state that results due to the experiences undertaken by the learner when employing the 'Six Thinking Hats' strategy, and is measured by the degree to which the learner responds to the phrases in the scales of the trend towards mathematics.

2. LITERATURE REVIEW

There are several studies that examined the 'Six Thinking Hats' strategy like Abdrabbu (2017), who found self-organized learning as effective in the development of achievement, the 'Six Thinking Hats' strategy as effective in the development of lateral thinking, but no impact of the two on achievement motivation. With respect to the 'Six Thinking Hats' strategy, Abdelhalim (2016) argued that this strategy and divergent thinking have greatly enhanced creative thinking abilities in academic writing. Habib (2013), on the other hand, aimed to detect the effectiveness of using this strategy in the development of geometric achievement and critical thinking; the results of this study found that there is a significant statistical difference between the experimental and control groups in both tests in favor of the experimental group. The study results reflect the effectiveness of the 'Six Thinking Hats' strategy in the development of habits of mind and in raising students' level of achievement (Hilal, 2013). Furthermore, Hauck (2010) stated that the teacher's use

of the 'Six Thinking Hats' in teaching leads to the development of students' questioning skills.

In addition, by examining the literature review we found several studies that examined creative thinking, like Al Bado (2017), who confirmed a positive relationship between intelligent learning and creative thinking. Rabie (2017), however, examined the effectiveness of a program proposed in the teaching of creative thinking to fourth grade students, in which the researcher applied Torrance's test for creative thinking, most outstanding result of Rabie's research was the existence of significant statistical differences between the pre and post scales of creative thinking, which indicates the effectiveness of the proposed program. In a more complex manner, the relationship between the components of the working memory and creative thinking in pre-school children was tested by Al Zayyat, et al. (2017) using the battery for measuring the working memory for children aged 4-6 years, along with a list of behavioral indicators for creative thinking for pre-school children. The main finding of the study was that all components of the working memory are related to creative thinking indicators (Al Zayyat, et al., 2017). Another study was designed by Kaware'a (2017) to identify the effect of the use of the STEM approach in the development of conceptual understanding and creative thinking in mathematics among ninth grade students. The researcher used a test for conceptual understanding and a test for creative thinking, and the results showed that there is a significant statistical difference between the mean scores of the experimental group and their peers in the control group in the conceptual understanding tests and the creative thinking, in favor of the experimental group (Kaware'a, 2017). Whereas Mushtaha (2015) aimed at determining the effectiveness of employing the augmented reality technique in developing creative thinking skills and trends towards science among ninth grade students in Gaza. The researcher used the test of creative thinking and the measure of the trend towards science. The results showed significant statistical differences between experimental and control groups in both measures; both differences were in favor of the experimental group. Bahar & Maker (2011), on the other hand, showed a correlation between mathematical achievement and mathematical creativity.

With respect to outstanding students, Abu Zeitoun (2017) found that the social interaction strategy is the highest dimension of the social coping strategies among students, while denial of knowledge was the least, and that extraversion was the top major personality trait, with openness being the least. The effectiveness of reciprocal teaching in the development of scientific matriculation and the academic achievement was studied by Legoun (2017) on a sample of outstanding students, in which the results provided evidence for the used method in empowering students toward high achievement.

Additionally, by applying a new program in the light of international standards for development of creative thinking and problem-solving skills of real-life problems in mathematics for outstanding high school students, Agha (2016) used the experimental method with a single group, on which a pre and posttest were applied, and used both the test of creative thinking and the test of life problems as study tools and showed the effectiveness of the proposed program in the development of creative thinking skills (fluency, flexibility, originality, sensitivity to problems) and the skills of solving life problems in mathematics among 11^{th} graders. Furthermore, through investigating the behavioral characteristics of outstanding students in Oman, Zubaidi et al. (2015) identified the top three behavioral characteristics of such students to be leadership, literacy and motivation; while, the lowest were found to be communication, theatrical characteristics and musical characteristics (Zubaidi et al., 2015). Finally, Hassan et al. (2012) established that teachers' behaviors and personalities influence students to be more inclined toward mathematics, and that students' tendency toward mathematics is influenced by the degree to which it's exposed to practical applications of daily life**.** From the previous literature, we can conclude that most studies conducted demonstrated a clear interest in the 'Six Thinking Hats' strategy, creative thinking skills, and outstanding students. It's also apparent that the interests of the studies and researchers are varied, where some them were interested in studying the impact of the 'Six Thinking Hats' strategy, while others studied creative thinking skills, and others applied their studies on outstanding students. We also realize that the studies have been carried out in different parts of the world, which means that the use of the 'Six Thinking Hats' strategy has already gained the interest of many researchers and is still doing so. Most of the previous studies used the experimental design that is based on the control group and the experimental group, except for some studies which used the descriptive approach; also most studies have revealed the impact of using the 'Six Thinking Hats' strategy on students' achievement. The results of these studies are important because they represented the starting point for this research inquiry, and acted as a guide for the researcher in the preparation and application of the research tools and procedures, as well as the discussion and interpretation of results.

3. METHODOLOGY

The researcher of this study used the quasi-experimental approach, using the design of a single group with a pre-post measurement. The population of the study consisted of high-achieving sixth grade students in mathematics for the academic year (2016- 2017). As for

the sample of the study, Sabha Al Harazeen Primary Boys School was selected in a targeted way, due to the existence of a cooperative and motivating educational faculty. The sample was also chosen in a targeted way to include (33) students, as follows:

- Selection of high-achieving students with a general average (90% or higher) in the first semester of the academic year 2017/2018, during which this research study was conducted.
- Among the high-achieving students selected, only those who were of the age of 10-years-or-less were chosen.
- From the students who met the previous criteria, only those who had not failed in any of the previous years were selected.
- Finally, from the students who passed all the above criteria, only those who fell within the highest quartile among their colleagues were chosen.

With respect to the research instruments used to achieve the objective of the study, the researcher used a test for creative thinking skills and a scale for students' trends towards mathematics, as explained below:

1. **Test of Creative Thinking Skills:** It was prepared based on the following steps:
   - **a.** ***Determining the test purpose***: This test was designed to measure the impact of the employment of the 'Six Thinking Hats' strategy on the development of creative thinking skills among sixth grade students who are high-achievers in mathematics.
   - **b.** ***Determining the creative thinking skills***: The researcher reviewed the literature on the issue of creative thinking skills, such as the studies of Al Bado (2017), Rabie (2017), Al Zayyat et. al (2017), Kaware'a (2017) and Mohammed (2016). He also analyzed the content of the second unit entitled "Geometry and Measurement" of the sixth grade mathematics book. Furthermore, the researcher surveyed the opinions of a sample of specialists in education through personal interviews (Delphi method), where he proposed a list of creative thinking skills needed for sixth grade students, consisting of the (3) main skills: fluency, flexibility, and originality.
   - **c.** ***The initial form of the test:*** The initial form of the test consisted of (18) essay questions.
   - **d.** ***Test Scoring:*** test was scored after the sample answered its questions, in which the scores were determined as follows:
     1. **Fluency:** A score is given for each correct answer after deleting duplicate answers.
     2. **Flexibility:** A degree is given to each entrance or idea of a solution with the elimination of duplicate ideas.
     3. **Originality:** The researchers adopted the criterion (KhairAllah, 1981: 13) to estimate the degree of originality as shown in the following table:

Frequency of the idea	1-9 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %
Score	10	9	8	7	6	5	4	3	2	1

Table 1. Illustrates the distribution of test scores:

Paragraph	Creative Thinking Skills			Total
	Fluency	Flexibility	Originality	
1	3	3	30	36
2	4	4	40	48
3	-	2	-	2
4	4	4	40	48
5	3	3	30	36
6	2	2	20	24
7	2	2	20	24
8	3	3	30	36
9	3	3	30	36
10	-	1	10	11
11	-	2	20	22
12	2	2	20	24
13	3	3	30	36
14	-	2	-	2
15	6	6	60	72
16	4	-	-	4
17	5	-	-	5
18	4	-	-	4
Total	48	42	380	470

Thus, the score obtained by the student is limited to (0 and 470).

- **e.** ***Exploratory experimentation of the test***: After the preparation of the initial test, it was applied on an exploratory sample of (30) sixth-grade students outside the study sample, for the purpose of calculating the difficulty and discrimination indexes of the test paragraphs, testing the validity and reliability of the test, and determining how long it takes to answer the test when applied to the study's actual sample.
- **f.** ***Analysis of the paragraphs of the test:*** The results of students' answers on the creative thinking skills test were analyzed in order to identify the degree of difficulty and discrimination index for each paragraph of the test, where the researcher found

that the difficulty index for each paragraph ranged from (0.43-0.77), which indicated graduated levels of difficulty. In addition to that, the discrimination index ranged from (0.38- 0.75) to distinguish between the responses of the upper and lower categories, where metrology accepts a discrimination index when it reaches more than (0.20) (Kilani et al., 2008: 448). Based on the above, the researcher kept all of the test paragraphs.

g. ***Validity of the test of creative thinking skills:*** The validity of the test was tested through presenting it to a group of (10) specialized university teachers and (8) educational supervisors, to be guided by their views on the appropriateness of the paragraphs of the test for sixth graders and to confirm the scientific and linguistic appropriateness of the vocabulary used in it. As a result, suggested modifications were taken into consideration. In addition, the internal consistency of the test was ascertained using Pearson correlation between the scores of each paragraph of the test and the total score, in which the researcher found that all values of Pearson correlation were statistically significant at significance level ($\alpha = 0.01$), which indicated that the test is strongly valid.

h. ***Reliability of the test of creative thinking skills:*** To check the reliability of the test of creative thinking skills, the researcher used Kuder–Richardson Formula 21 and found that the reliability coefficient is (0.847), which is a highly reliable and statistically significant coefficient.

i. ***Determining the test duration:*** The time needed to answer the test of the creative thinking skills was determined by calculating the mean time it takes for the first and last student to finish the test; it was found to be (70 minutes).

j. ***The final form of the test of creative thinking skills*****:** Based on the results of the arbitration and exploratory experimentation of the test and doing the necessary modifications, the number of test paragraphs after adjustment was (18) essay questions, ready to be applied in its final form.

2. Scale for Students' Trends towards Mathematics

The researchers prepared a scale for the trends towards mathematics in order to be used to identify the attitudes of sixth grade students, who are high-achievers in mathematics, towards mathematics, before and after the implementation of the 'Six Thinking Hats' strategy. The scale, in its final form, included 40 paragraphs that measure three dimensions, which are: the trends towards the appreciation of the importance and value of mathematics (12), enjoying the learning of mathematics (14), and interest in mathematics (14). The scale was prepared based on the following steps:

a. ***Determine the scale purpose***: This scale was designed to measure trends towards mathematics among sixth grade students before and after the application of the 'Six Thinking Hats' strategy.

b. ***Determining the areas of the scale***: The areas of the scale were three: appreciation of the importance and value of mathematics, enjoyment of mathematics learning, interest in mathematics.

c. ***Phrasing the scale's paragraphs***: The phrases of the scale were formulated in a procedural form, by which the number of phrases in its initial form was (45) phrases divided into four fields.

d. ***The scaling and correction of the scale:*** Student responses were formulated according to the Quintet Likert scale (strongly agree "five points", Agree "four points", neutral "three points", Disagree "two points", and strongly disagree has "one point") for positive phrases, and vice versa for negative phrases

e. ***The validity of the Scale:*** the validity of the instrument was tested through:

- ***Validity of the arbitrators:*** The scale was presented to a group of arbitrators from specialists in education, curriculum and teaching methods in the Palestinian universities, to be guided by their views on the appropriateness of the paragraphs of the scale, as well as to ensure the validity and clarity of its language.
- ***Internal consistency***: Internal consistency was ascertained using Pearson correlation between the scores of each area of the scale and the total score, and also by applying the instrument on an exploratory sample of (30) students outside the study sample, and were as follows (0.854, 0.884, 0.773) respectively, which indicated that the scale is strongly valid.

f. ***The reliability of the scale:*** The reliability of the scale was calculated using Cronbach's alpha coefficient to measure the reliability of each area and the phrases of the scale as a whole. The reliability coefficients were as follows (0.901, 0.907, 0.845, 0.936), which indicated that the scale has a high degree of consistency of its vocabulary.

4. Analysis and Discussion of Results

The Statistical Package for Social Sciences (SPSS) was used to perform the required analysis, in which the (T-test) for two independent samples was used to study the differences between the variables of the study, in addition to calculating the size of the impact of

the employment of 'Six Thinking Hats' strategy through calculating ETA square (η2).

Based on the study questions and hypotheses, the following results were obtained:

- **Results of the first question:**

  What creative thinking skills should be developed among sixth grade high-achieving students in mathematics?

  To answer this question, the researchers prepared a list of creative thinking skills by reviewing the research literature and by analyzing the content of the second unit of the sixth grade math book entitled "Geometry and Measurement", in addition to a sample survey of opinions of specialists in education. In light of this, the list of creative thinking skills necessary for sixth grade students, consisted of the following (3) skills:

  - Fluency: The student's ability to generate the greatest number of correct solutions for the mathematical problem, measured by the scores obtained by students on the measure of fluency in the test of creative thinking.
  - Flexibility: The student's ability to generate a number of ideas to solve the mathematical issue, measured by the grades obtained by students on the measure of flexibility in the test of creative thinking.
  - Originality: The student's ability to solve the mathematical problem is a non-repetitive solution, measured by the degree to which the students are able to measure the skill of originality in the test of creative thinking.

- **Results of the second question:**

  What is the impact of the employment of the 'Six Thinking Hats' strategy on the development of creative thinking among sixth grade high-achieving students in mathematics?

  To answer this question, the first hypothesis of the study was formulated, stating that there are no significant statistical differences ($\alpha \leq 0.05$) between the mean scores of the high-achieving students in the pre and posttests of creative thinking skills. To test this hypothesis, T-test was used for two independent samples; the results were as illustrated in Table (2).

Table 2. shows the results of T-test to compare the mean scores of high-achieving students in the pre and post -tests of creative thinking skills

Variable	Exp. Group	No.	Mean	Std. D	Cal. T-Value	Sig
Fluency	Pre	33	8.79	3.95	-27.06	0.00
	Post	33	30.85	6.42		
Flexibility	Pre	33	6.97	3.26	-25.74	0.00
	Post	33	29.67	6.51		
Originality	Pre	33	25.94	12.83	-23.11	0.00
	Post	33	263.33	63.68		
Overall Test	Pre	33	41.70	19.32	-24.32	0.00
	Post	33	323.85	75.51		

Limits of statistical significance begin at the level (α = 0.05), d.f. (32) when the tabulated T-value is (2.00)

Limits of statistical significance begin at the level (α = 0.01), d.f. (32) when the tabulated T-value is (2.66)

It is clear from the above table that the calculated T-value equals to (27.06, 25.74, 23.11, 24.32), respectively which is greater than the tabulated T-value (2.66), at the degree of freedom (32) and the level of statistical significance (α = 0.01). This indicates the existence of significant statistical differences between the mean scores of the high-achieving students in the pre and post -tests of creative thinking skills; these differences are in favor of the post-test. This result is consistent with several previous studies, such as the study of Rabie (2017), Kaware'a (2017), and Agha (2016).

Regarding the size of the impact of the employment of the 'Six Thinking Hats' strategy on the development of creative thinking skills among sixth graders, ETA square (η2) was calculated to make sure that the size of the T-test resulting differences are real differences caused due to the study variables, and are not coincidental. The following table illustrates this :

Table 3. shows the size of the impact of the t-test of the differences between the scores of high-achieving students in the pre and post- tests of creative thinking skills

Variable	Calculated T-Value	Value of ETA square (η2)	d value	Size of impact
Fluency	-27.06	0.958	4.784	Large
Flexibility	-25.74	0.954	4.550	Large
Originality	-23.11	0.943	4.085	Large
Overall Test	-24.32	0.949	4.299	Large

It is clear from the above table that the value of ETA square equals to (0.958, 0.954, 0.943, 0.949) respectively, which indicates a large impact, since Afaneh (2000: 42) indicates that the size of impact is considered large if the value of ETA square is greater than or equal to (0.14), as is the size of the impact is considered supplementary to the statistical significance, and does not replace it. The success of 'Six Thinking Hats' strategy to improve the creative thinking skills among primary sixth-graders may be due to the following reasons:

- Employing the 'Six Thinking Hats' strategy stimulates competition among students, effectively contributing to their motivation, raising their level of ambition and their continuing desire to accomplish other activities; which has had a significant impact on their increased acquisition of creative thinking skills.
- The adoption of the 'Six Thinking Hats' strategy in student activities, makes the student the focus of the educational process, and thus eliminates the boredom of students during the educational situation, which motivates the students to be participative, effective and thoughtful.
- Using this strategy has helped to diversify activities and questions that develop creative thinking skills.
- This strategy gave a prominent role for the learners in class participation by wearing the six hats, which deepened their ideas and gave them opportunities for creativity and practicing different and varied ways of answering.
- This strategy was based on the motivation of students to research and inquire, which led to the stimulation of their ideas and to the generation of a large number of questions, and this developed their ability to think of solutions in all directions, and solve the problems they face in more than one way.
- Employing the 'Six Thinking Hats' Strategy made the learners free from the routine of the teaching process, and gave them a new learning experience.

➢ **Results of the third question:**
What is the impact of the employment of the 'Six Thinking Hats' strategy on the development of trends towards mathematics among sixth grade students highly achieving in mathematics?
To answer this question, the second hypothesis of the study was formulated, stating that there are no significant statistical differences ($\alpha \leq 0.05$) between the mean scores of the high-achieving students in the pre and post scale of trends towards mathematics. To test this hypothesis, T-test was used for two independent samples; the results were as illustrated in Table (4).

Table 4. shows the results of T-test to compare the mean scores of highly achieving students in the pre and post scale of trends towards mathematics

Variable	Exp. Group	No.	Mean	Std. D	Calculated T-Value	Sig
Appreciation of the importance and value of mathematics	Pre	33	2.20	0.59	-21.36	0.00
	Post	33	4.65	0.30		
Enjoying the learning of mathematics	Pre	33	2.08	0.65	-20.93	0.00
	Post	33	4.69	0.29		
Interest in mathematics	Pre	33	2.02	0.63	-20.72	0.00
	Post	33	4.60	0.35		
Overall Questionnaire	Pre	33	2.10	0.60	-22.00	0.00
	Post	33	4.64	0.29		

Limits of statistical significance begin at the level (α = 0.05), d.f. (32) when the tabulated T-value is (2.00)
Limits of statistical significance begin at the level (α = 0.01), d.f. (32) when the tabulated T-value is (2.66)

It is clear from the above table that the calculated T-value equals to (21.36, 20.93, 20.72, 22.00) respectively, which is greater than the tabulated T-value (2.66), at the degree of freedom (32) and the level of statistical significance (α = 0.01). This indicates the existence of significant statistical differences between the mean scores of the highly achieving students in the pre and post scale of trends towards mathematics; these differences were in favor of the post scale.

Regarding the size of the impact of the employment of the 'Six Thinking Hats' Strategy on the development of trends towards mathematics among sixth graders, ETA square ($\eta 2$) was calculated to make sure that the size of the T-test resulting differences are real differences caused by the study variables, and are not coincidental. The following table illustrates this :

Table 5. Shows the size of the impact of the t-test of the differences between the scores of highly achieving students in the pre and post scale of trends towards mathematics

Variable	Calculated T-Value	Value of ETA square (η2)	d value	Size of impact
Appreciation of the importance and value of mathematics	21.36	0.894	2.907	Large
enjoying the learning of mathematics	20.93	0.890	2.848	Large
interest in mathematics	20.72	0.888	2.820	Large
Overall Questionnaire	22.00	0.900	2.994	Large

It is clear from the above table that the value of ETA square equals to (0.894, 0.890, 0.888, 0.900) respectively, which indicates a large impact, since Afaneh (2000: 42) indicates that the size of impact is considered large if the value of ETA square is greater than or equal to (0.14), as is the size of the impact is considered supplementary to the statistical significance, and does not replace it. The success of the 'Six Thinking Hats' strategy to improve the trends towards mathematics among primary sixth-graders may be due to the following reasons:

- The presentation adopted by the 'Six Thinking Hats' strategy, which included the use of sensory examples that are close to the students, lively activities, exciting equations, and constant movement, provided an opportunity to stimulate students' motivation to participate and to extract their potential, which led to the correlation of more students with mathematics.
- Increased students' participation had a positive impact on their trends towards learning mathematics.
- The 'Six Thinking Hats' strategy made students love mathematics by engaging them in the presentation of lessons.
- The 'Six Thinking Hats' strategy took into account individual differences among students, by giving them the opportunity to wear the different hats.
- The strategy increased the motivation of students toward learning and achievement through competition among students on wearing the hats.
- Interaction between students during the lessons makes students more friendly with their peers and more interested in the presented lessons.
- Setting a mutual goal, as per the 'Six Thinking Hats' strategy, by making students bear the responsibility for their learning, helped create positive trends towards mathematics and its subjects.

5. STUDY RECOMMENDATIONS:

In light of the research study's findings, the following recommendations can be made:

1. Those responsible for the development of mathematics curricula at the elementary level/ primary stage need to focus on preparing activities and exercises that enable students to exercise creative thinking skills, and not just be limited to activities and exercises that focus on memorization of mathematical information and knowledge.
2. There is a need to train mathematics in-service teachers, through courses, workshops, and other teaching methods, on the use of modern teaching strategies such as the 'Six Thinking Hats' Strategy, as to positively develop learners' creative thinking skills and trends towards mathematics.
3. There is a need to include in the teaching of mathematics topics in which the 'Six Thinking Hats' strategy can be incorporated, as well as other different strategies that help students develop creative thinking skills and positive trends towards mathematics.
4. There is a need for the teacher's math guidebook prepared by the Ministry of Education, to include models of how to present some lessons using the 'Six Thinking Hats' strategy for the development of creative thinking skills and trends towards mathematics.
5. Classes for developing the creativity and innovative skills of high-achieving students need to be held.
6. Conducting similar studies at various educational stages, and testing the impact of the 'Six Thinking Hats' strategy on different learning outcomes, is necessary.

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Appendix (1)
Scale of Trend Towards Mathematics

Student's name.....
Class .....

Instructions:

Dear student
Please read these instructions carefully before answering the scale phrases.
The following 40 phrases measure the trends towards mathematics. You should try to answer all the phrases by inserting a (√) mark in front of each phrase in the corresponding column that reflects your opinion.

For Example:

Phrase	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1- Mathematics help develop methods of proper thinking					

If you feel that you strongly agree with this phrase, place a (√) in the strongly Agree column; if you agree with this statement, tick (√) in the Agree column, but if you are neutral, place a (√) in the neutral column. In case you disagree or strongly disagree with this phrase, place a (√) in the correspondent column accordingly.

Dear student, please follow this:

1. Place only one check mark for each phrase.
2. There are no correct and wrong answers.
3. Do not leave any phrase without expressing your opinion.
4. Please be informed that there are no restrictions in your opinion.
5. Please be informed that your opinion will benefit scientific research in the development of the material, which will benefit you and your colleagues.

Phrase	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Axis #1: Estimating the importance and value of mathematics					
1- Mathematics helps develop proper thinking					
2- Mathematics is one of the important educational subjects					
3- Mathematics is a main subject					
4- Mathematics is necessary for all students					
5- Mathematics is valuable and necessary because it benefits society					
6- All people need math in their lives					
7- Math is fun and entertaining					
8- Mathematics develops my abilities					
9- Mathematics teaches me to raise questions, opinions and ideas					
10- Mathematics is important in life					
11- Mathematics has contributed to the development of my mathematical imagination					
12- Mathematics has made me more precise and organized.					
Axis #2: Enjoying the Learning of Mathematics					
1- I feel sad when the mathematic class is over					
2- I enjoy studying mathematics					
3- I enjoy reading the mathematics book					
4- I feel comfortable when I study mathematics					
5- I eagerly wait for the math class					
6- I want to spend more time learning math					
7- I'm thinking well when solving mathematical problems					
8- I remain quiet in the math class					
9- Math study makes me feel safe					
10- I enjoy math study so much					
11- Thinking about solving mathematical problems makes me happy					
12- I love mathematics because it contains a lot of symbols and equations					
13- Mathematics is the best class among all other subjects					
14- I feel that the time passes quickly during Mathematics class.					
Axis #3: Interest Mathematics					
1- I love to study mathematics					
2- When doing my homework, I always begin with Mathematics homework					
3- Mathematics is my favorite					
4- I'm very interested in mathematics					
5- I prefer math on all other subjects					
6- Mathematics is a favorite subject for all students					
7- I prefer fractal geometry on other math topics					
8- I am very interested in subjects of mathematics					
9- Learning mathematics is easy					
10- I do well in mathematics					
11- I have a good sense of satisfaction when solving mathematical problems					
12- I feel happy when I hear the word math					
13- I feel a positive interaction with mathematics					
14- I love mathematics because it contains many theories					

Appendix (2)
Test of Creative Thinking for Grade 6
Unit of Geometry and Measurement

Student Name: …….

Answer all of the following questions:

Q#1: Given a parallelogram with circumference 24 cm, find lengths of sides in more than one way?

Q#2: Can I make a parallelogram through a rectangular carton box? Explain this in several ways?

Q#3: Amal wants to make a parallelogram by 30 cm of wire, given length of one sides is 5 cm, using drawing, how do you choose the other sides of a parallelogram?

Q#4: How do I make a trapezoid by cutting a rectangular carton box?

Q#5: Draw a trapezoid, and indicate the number of axes of symmetry in it?

Q#6: Khalid has a wooden piece, its edges are in the form of an equilateral trapezoid, the measure of one angle of the two parallel bases is 35^5 , what is the measure of the other three angles?

Q#7: Draw a parallelogram and represent its heights in more than one way?

Q#8: Draw a trapezoid and represent its heights in more than one way?

Q#9: Given a garden in the shape of a parallelogram, the length of its base 20 m, height 18 m, with a surrounding corridor of width 2 m, calculate the area of the corridor in more than one way?

Q#10: Given area of a parallelogram 20 cm, with a base length 10 cm, calculate its height?

Q#11: Given ABCD trapezoid with two equal base angles, each equals 110^5, what is the measure of the two remaining angles? What is the name of the trapezoid?

Q#12: Given an Isosceles trapezoid with perimeter 20 cm, length of its parallel bases 7 cm and 5 cm, calculate the length of it sides?

Q#13: Draw ABCD parallelogram, and connect its diameter AC and BD to intersect at point M, prove in more than one way that each opposite angles are equal?

Q#14: Given a parallelogram with measure of one of its angles 100^{5}, illustrate the ways to find its remaining angles?

Q#15: Draw ABCD parallelogram, using the drawing, prove that each of its diameters divides the other into two equal radiuses in more than one way.?

Q#16: List several Quadrilateral from parallelogram family?

Q#17: List the properties of parallelogram which you have studied in the unit?

Q#18: List the properties of trapezoids which you have studied in the unit?